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DRAWINGS ATTACHED

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(54) IMPROVEMENTS RELATING TO FLUID MATTRESSES

(71) We, NATIONAL RESEARCH DEVELOPMENT CORPORATION, a British Corporation established by Statute, of Kingsgate House, 66-74 Victoria St., London, S.W.1., do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to fluid, especially air, mattresses to provide yielding support for the human body. Although the invention has primarily been developed and will hereinafter be described in relation to mattresses to support a recumbent human body, it is to be understood that the term mattress when used generally herein includes cushions and resilient seats and chairs, such as for example wheel chairs. Equally although developed to support the human body, manifestly mattresses or the like in accordance with the invention may be used to support any form of load requiring the conforming yielding support it is the object of the invention to provide.

The present invention is defined by the claims and is further described, by way of example, with reference to the accompanying drawings in which:—

Figure 1 is a diagrammatic plan view of a known form of fluid mattress;

Figure 2 is a section, on an enlarged scale, taken on the lines II-II of figure 1;

Figure 3 is a diagrammatic plan view of a fluid mattress according to the invention;

Figure 4 is a section, on an enlarged scale, taken on the lines IV-IV of figure 3;

Figure 5 is an enlarged detail of figure 4;

Figure 6 is a side elevation of a practical form of fluid mattress and bed according to the invention;

Figure 7 is a fragmentary section, on an enlarged scale, taken on the lines VII-VII of figure 6;

Figures 8 and 9 are side views of a group of cells, before and after incorporation in the mattress, illustrating a modified form they may take; and

Figures 10 and 11 are views similar to figures 8 and 9 illustrating another form of construction.

With reference to figures 1 and 2, a known form of fluid mattress 1 for supporting a recumbent human body 2 comprises a plurality of air-filled cells 3 of flexible material and elongated form disposed in a row extending from one end of the mattress to the other to provide yielding support for a human body 2. The cells 3 are interconnected so that the cells are all inflated to the same pressure.

As shown in figure 2, the known form of mattress 1 does not accommodate itself to the recumbent body 2 to a degree whereby the body is supported substantially uniformly. This is because the degree of yield possessed by the mattress is limited by tension forces set up in the cell material, and the localised support which results can lead to sores developing on such parts of the body as the heels, buttocks, elbows and shoulder blades. As shown in figure 2, when the body 2 is placed on the mattress 1, the upper surfaces of the cells 3 supporting the body deflect downwardly, drawing the ends of the cells inwardly as they do so. However, the degree of deflection is limited by tension loads and high shear resistance in the cell material whereby the upper surface of each cell acts like a taut rope in supporting the associated part of the body 2. Hence the body 2 is supported by "point" contact rather than the desirable "line" contact, and any tendency of the two "points" 2*a*, 2*b* of the body to move laterally apart relative to each other is resisted by the "bridge" 3*a* of taut material between them. Any tendency to move together is similarly resisted by the taut material at 3*b*. Furthermore, because the cell inflation pressure is substantially

uniform, and some parts of the human body are denser than other parts, the support for the less dense parts, for example, the legs, is unyielding.

With reference now to figures 3 to 5, a fluid mattress 11 according to the invention comprises a plurality of discrete inflatable contiguously arranged cells 13*a*, 13*b* and 13*c* disposed in three end to end or longitudinally aligned rows *A*, *B*, and *C*, to provide support for a recumbent human body 2. The cells are also transversely aligned, i.e. across the mattress from one side to the other.

The cells are formed of flexible, preferably substantially inextensible material, so as to be independently depressible. Provision is made independently to inflate the cells or at least selected groups of them. As a result, when a load is placed on the mattress, instead of a uniform pressure being established throughout the cells corresponding to the total load, individual cells, or groups of them as the case may be, will be compressed to establish a pressure therein merely sufficient to balance the load imposed on each cell or group of cells.

The initial pressure to which the cells are inflated will, of course, be less than that required to bear the load to be imposed upon them, since otherwise they would be substantially unyielding. To cater for the different density of different parts of the body those cells, or groups of cells, which will bear the relatively heavier parts of the body will be inflated to a relatively higher pressure than those to support the relatively lighter parts of the body.

To ensure that the upper surfaces of the cells fully conform to the contour of the body, the cells are so formed that depression of their upper surfaces is not limited by the production of tensile forces therein. This may be arranged in a variety of ways, as will be further explained below. Essentially all that is required is that there should be sufficient lack of tensile forces in the walls and/or the upper surfaces of the cells, prior to a body being placed upon them. Conveniently either the upper surfaces or side walls of the cells are formed with excess material.

In the embodiment illustrated the relative dimensions of the rows of cells 13*a*, 13*b* and 13*c* are such that the trunk of the body 2 is primarily supported by the centre row *B* of cells 13*b*. It has been found that the side to side dimensions S-S (see figure 4) vary by only a few inches from women of slim build to men of larger than average build, and thus a mattress having cells of standard dimensions can be made which will provide support as required for persons of varying sizes and profiles. In practice the cells 13*b* will be given lateral dimensions a few inches less than the smallest S-S dimension of the range of persons expected to use the mattress.

With this arrangement the cells 13*b* can readily accommodate themselves to support the major portion of the trunk of the body, this occuring partly by downward deflection of the upper surface of the cells and partly by differential downward movement or shear between the sides of adjacent cells. The remainder of the weight of the trunk is supported by the outer rows *A* and *C* of cells 13*a* and 13*c*, the sides of which, which abut the centre row *B* of cells along lines in substantial alignment with the side regions of the trunk of the body, being inwardly deflected in the region of their upper corners. The legs of the body are supported by cells from all three rows, the arms by cells 13*a* and 13*c* in rows *A* and *C* respectively, and the head by a few cells 13*b* in row B. By virtue of the manner in which the cells will be independently inflated, a variable pressure P will be built up within the cells due to their variable compression to establish individual pressure balances yieldingly to support the loads experienced by them.

With reference now to figures 6 and 7, a practical form of bed using the mattress 11 comprises a spaced-apart pair of tubes 20 inter-connected by tie-bars 21 (figure 6 only) and supported above the ground 22 by swivel-mounted legs 23. The tubes 20 are of articulated form, each tube comprising four blind-ended tube sections joined together by pin joints 24.

The mattress 11 is supported by a plurality of rods 25 extending laterally between adjacent pairs of cells 13*a*, 13*b*, 13*c*, and passing through loops formed by strips 26 of flexible material stitched to the cells. The strips 26 of one cell alternate with the strips 26 of its oppositely facing neighbour so that a single rod 25 locates pairs of cells 13*a*, 13*b* and 13*c*.

The rods 25 extend between and rest upon the tubes 20 and are attached thereto by locating devices (not shown) such as clips. the tubes 20 carry rows of inwardly extending stub pipes 27 which penetrate the outer side parts of the cells 13*a* and 13*c* and are attached thereto by seals 28. The pipes 27 connect the interiors of the cells 13*a* and 13*c* with the interiors of the tubes 20 and each section of the latter is connected to the outlet of an air compressor (not shown) by way of ducts 29 provided with flow control and shut-off valves 30. The supply of compressed air is temperature controlled and filtered using known means.

The interiors of the cells 13*a*, 13*b* and 13*c* are inter-connected by holes 31 defined by eyelet fastenings 32 which also attach each lateral group of cells to each other. As shown in figure 6, longitudinal movement of the cells of the mattress 11 is restricted by upright-disposed boards 38 attached to and extending between the ends of the tubes 20.

Conveniently the cells of the mattress are formed by cementing together thin (e.g. 0.020") sheets of "HYPALON" (Regd. Trade Mark) coated nylon weighing about 3 oz per sq. yard. This material has a slight porosity. For a mattress formed of three longitudinal rows of cells of substantially rectangular form, the cells may be of the order of 10" high, 13" wide and 3" long. Each longitudinal row then conveniently comprises 36 cells giving a total for the mattress of 108.

The cells are so arranged that when inflated their adjacent sides abut each other to restrict sideways movement of them and to constrain them from adopting the lateral dimensions they would assume if unrestrained. In fact the cells will be so formed that if unrestrained on inflation they would adopt a shape substantially circular in plan. By being arranged mutually to restrict themselves from adopting such a form, "excess" material is effectively provided in the sides of the cells which will then not be so tensioned by vertically acting tensile forces as to restrict the ability of the upper surface of the cells to sag and conform with a load or body placed upon them.

In operation, to support the body 2, the valves 30 are opened to inflate the groups of cells associated with the four sections of the tubes 20. To support a man of average weight inflation pressures of between about 25 to 40 lbs per sq. ft. are used. To be more specific, due to their varying densities, it is found that the pressure in the middle two groups of cells intended to support the trunk and thighs of the body require to be inflated to pressures of the order of 40 and 35 lbs per sq. ft. respectively, the groups of cells supporting the legs and head requiring to be inflated to a pressure of approximately 25 lbs per sq. ft. Apart from it being necessary to vary the pressure between groups of cells supporting the different parts of the body to ensure that the pressures that will be built up therein will in fact support the body, it is also desirable that the pressure should be varied, so that the body is supported in a comfortable attitude. The required adjustment of the pressure in the groups of cells can readily be effected by appropriate adjustment of the valves 30, either before or during use.

To increase the comfort of the body 2 the slopes of the legs 23 can be adjusted so that the sections of the tubes 20 are positioned so as to vary the attitude of the body.

The mattress of the invention provides comfortable support to the body 2, reducing any tendency for the formation of bed-sores. The porosity of the material used in the construction of the cells of the mattress allows a steady escape of inflation air to take place from within the cells and this atmosphere-seeking flow of air removes body perspiration and this flow of air by appropriate control of the temperature of the air can be utilised to cool or warm the body.

If a non-porous material is used for making the cells, the latter can be made porous, for example, by running cell material through a sewing machine, without using thread, so that the needle of the machine makes air escape holes in the material.

The cells may be parted or removed to allow, for example, the use of a bed pan. A person may also be bathed on the bed 11. When this is done, the water used will drain away between adjacent cells and, if porous material is used for constructing the cells, escaping cell inflation air will assist in drying the body.

The limbs and other parts of the body can be exercised by opening and closing one or more of the valves 30 whereby the inflation pressure of the associated group(s) of cells is raised and lowered, resulting in vertical movement of the body limbs.

It is to be understood that a mattress, in accordance with the invention, may be formed by cells constructed and arranged in a variety of ways. Thus plainly more than three longitudinal rows of cells may be employed if desired, and further it is not essential that they be longitudinally and transversely aligned. They might equally, if desired, be arranged in staggered formation. Also, the degree to which the individual cells may be inter-connected, if at all, may be varied widely. Obviously more than four independently inflatable groups of cells may be provided, and inter-connections may be provided between longitudinal as well as, or instead of, between transversely aligned groups of cells.

One modified way in which the cells may be formed is shown in figures 8 and 9. In this case the three cells 13*a*, 13*b* and 13*c* are formed from a single piece of material, gussets or fillets 45 being provided between the cells. Thus, if unrestricted, on inflation the cells would adopt the configuration shown in figure 8. In fact they will be vertically constrained as shown in figure 9, so that in operation the gussets 45 are restrained from expanding and will provide excess material which will avoid the undesired restriction of the upper surface of the cells against depression to conform to the contour of a body.

A further alternative, but generally comparable construction, which may be employed, is shown in figures 10 and 11. In this case a cell is so formed that if unrestrained on inflation it would adopt a generally arcuate form as shown in figure 10. Again, however, it will be restrained from adopting this form, and will be held to remain substantially horizontal, so that its central portion, as indicated in figure 11, will

be puckered, in effect to provide excess material in its upper surface. The cell may or may not, as desired, be partially or wholly divided to provide separate cells 13*a*, 13*b* and 13*c*.

WHAT WE CLAIM IS:—

1. A mattress to provide a conforming and yielding support surface, e.g. for the human body, comprising a plurality of discrete, independently depressible, contiguously arranged cells and means to establish pressures in at least some cells different from those in others, in which the mattress is connected by way of flow control valves to a source of compressed air and is formed with air escape holes so that inflation air may steadily escape from the cells, and in which when the mattress is unoccupied and the cells are inflated the walls of contiguous cells abut, thus limiting such cells to lateral extents less than they would possess if inflated and unrestrained.

2. A mattress according to Claim 1 in which the cells are aligned in rows running both transversely and longitudinally relative to the mattress.

3. A mattress as claimed in either of the preceding claims and suitable for a human bed, in which the cells are arranged in at least four independently inflatable groups, one group each being appropriately placed to receive the head, trunk, thighs and legs respectively of a recumbent human body.

4. A mattress according to any of the preceding claims in which at least some of the material from which the cells are formed is porous.

5. A mattress according to any one of the preceding claims, substantially as described with reference to Figures 3-11 of the accompanying drawings.

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1,273,342 COMPLETE SPECIFICATION
4 SHEETS

Fig. 1.

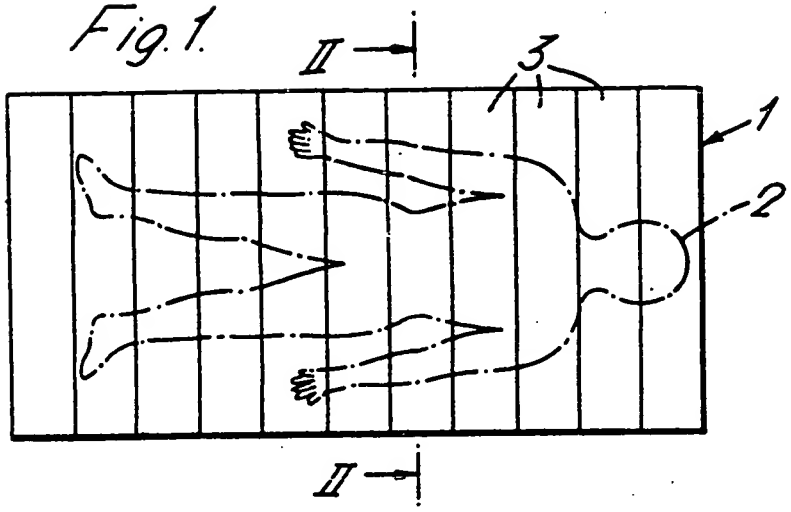


Fig. 2.

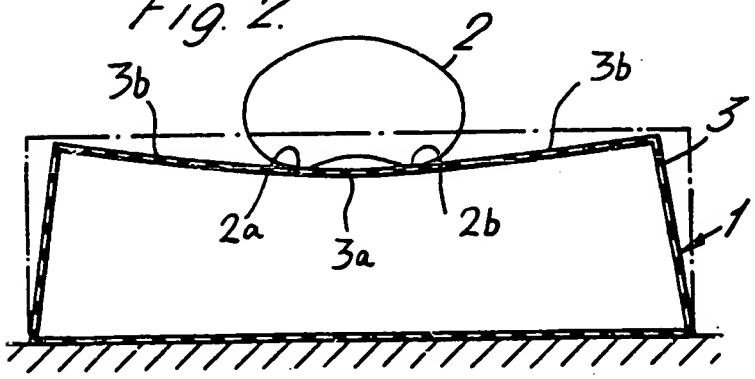
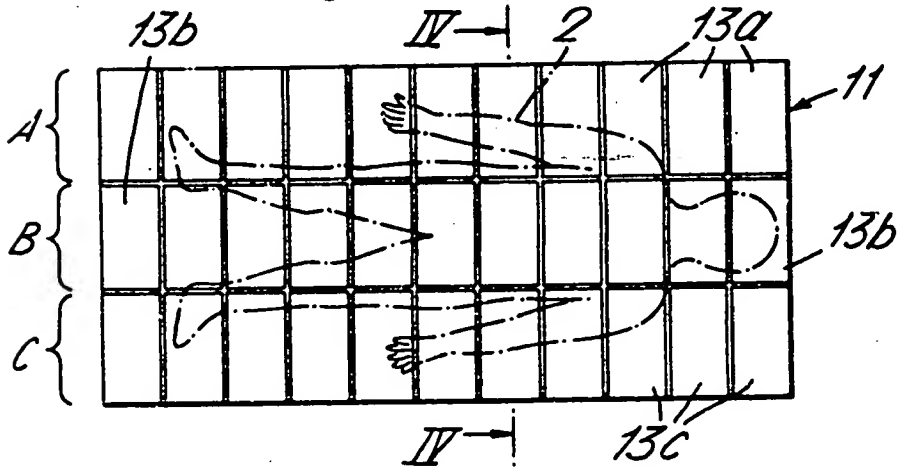


Fig. 3.



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COMPLETE SPECIFICATION

SHEET 2

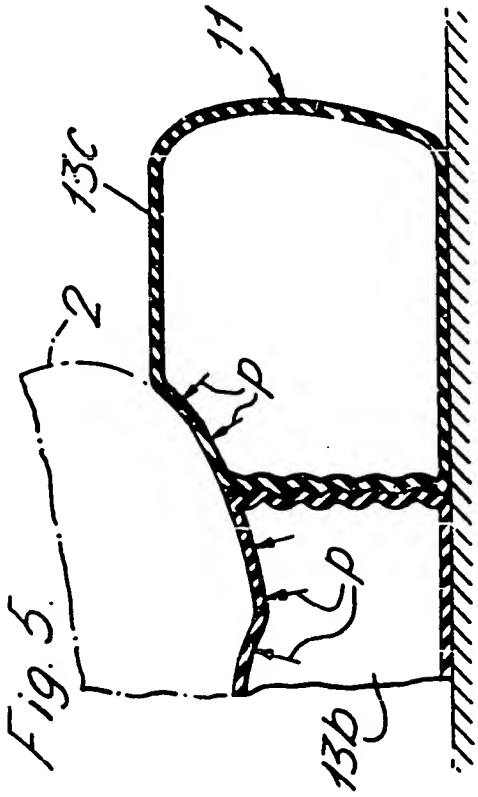

Fig. 5.

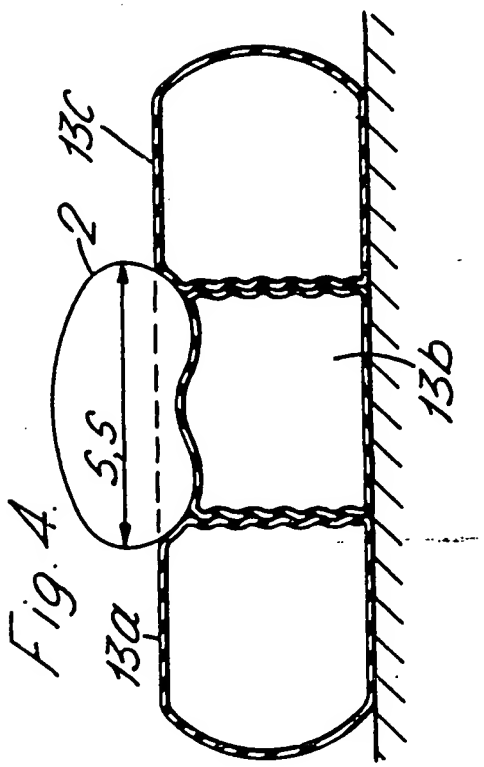

Fig. 4.

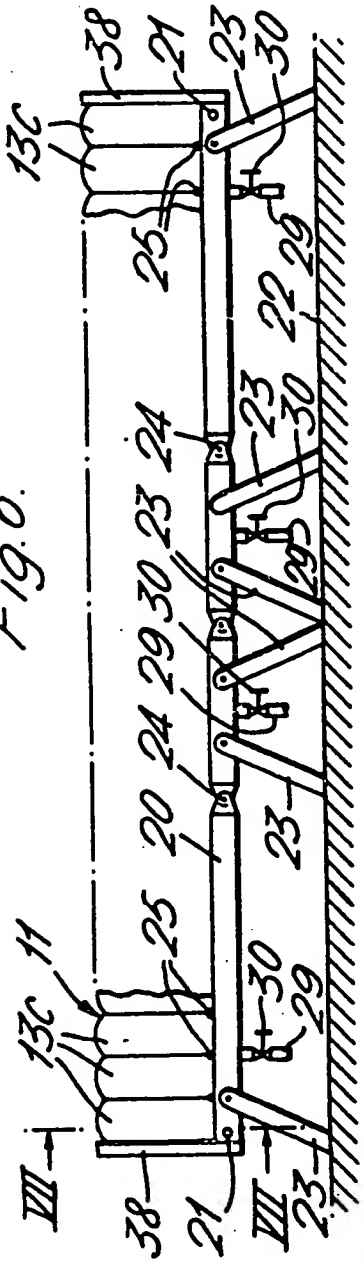

Fig. 6.

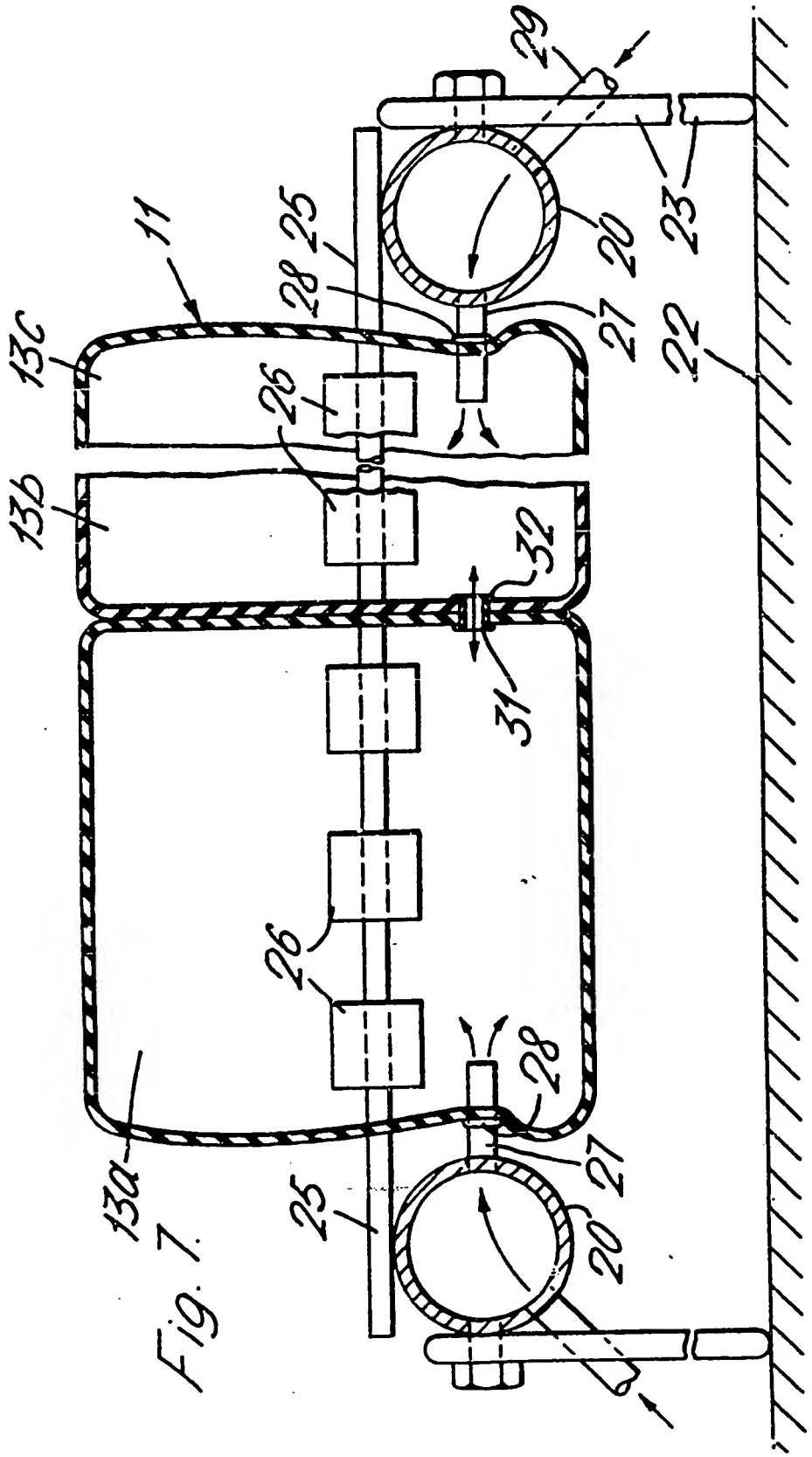

Fig. 7.

Fig. 8.

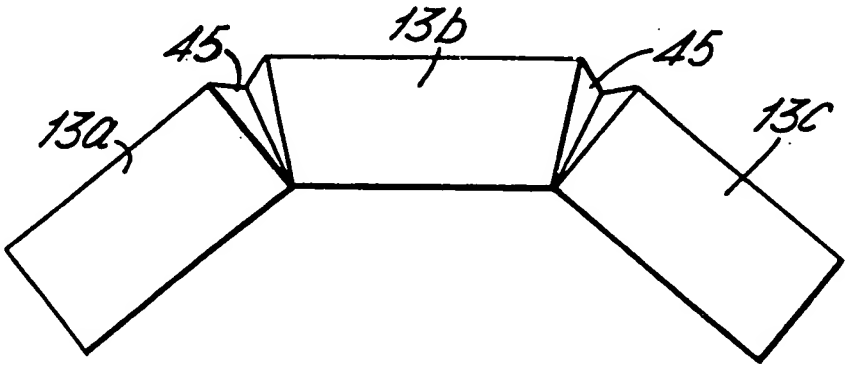

Fig. 9.

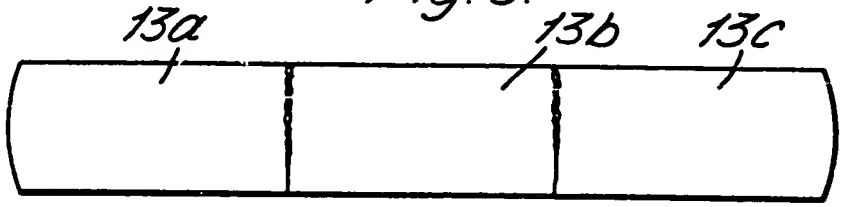

Fig. 10.

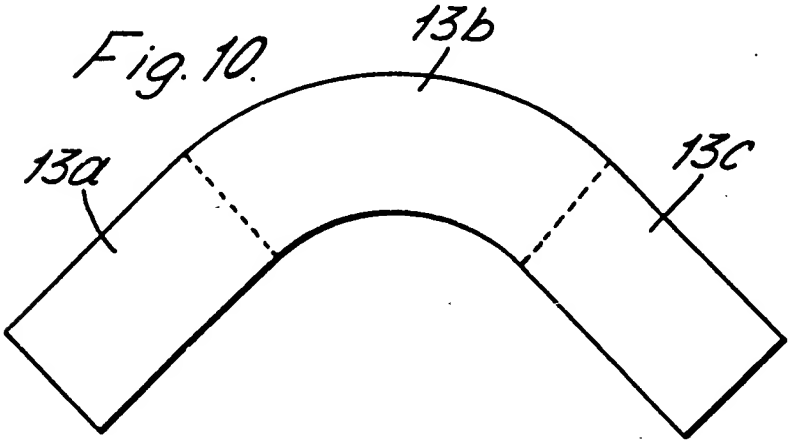

Fig. 11.